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EP-93

Canal Zone Analogs IV

ANALOGS OF CANAL ZONE CLIMATE IN WEST CENTRAL AFRICA

QUARTERMASTER RESEARCH & ENGINEERING CENTER

ENVIRONMENTAL PROTECTION RESEARCH DIVISION

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Quartermaster Research & Engineering Center
Natick, Massachusetts

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ANALOGS OF CANAL ZONE CLIMATE IN WEST CENTRAL AFRICA

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FOREWORD

A successful research, development, or training program requires a knowledge of the extent of environmental representativeness of test sites and training areas. The Quartermaster Corps, at the request of the Corps of Engineers, Waterways Experiment Station, under a directive from the U.S. Army General Staff, is developing a generalized comparative climatic picture of the wet tropics throughout the world by a series of tropical analog studies. The series parallels another already completed, which presented comparisons between Yuma, Arizona, and the various desert regions of the Northern Hemisphere.

This is the fourth report of the tropical series. It compares the Canal Zone climate with that of West Central Africa, and by so doing provides a climatic reference for military planners and test personnel.

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ABSTRACT

The results of climatic testing in the Canal Zone may be applied with considerable confidence to much of the northern shore of the Gulf of Guinea. The climate of the coast is closely analogous to that of either the Atlantic or Pacific side of the Canal Zone except for the western part of the Bight of Benin.

Close analogy to Cristobal, representing the wetter, windward, Atlantic side of the Canal Zone, is found in the wetter parts of the study area at the head of the Bight of Biafra and seaward of the Guinea Highlands. Close analogy to Balboa Heights, representing the drier, leeward, Pacific side of the Canal Zone, occurs on the east side of the Guinea Highlands, on the coast between the Guinea Highlands and the west side of the Bight of Benin, on the eastern shore of the Bight of Benin, on the upper Niger delta, and on the southern and eastern sides of the Cameroons-Gabon Plateau.

Analogy with the various single elements mapped in this study is generally coastal in distribution, extending north in some instances to cover the Sudan. The Atlantic coast of the Sahara and certain Saharan uplands are analogous only for temperature of the warmest month; otherwise, the Sahara is not analogous.

ANALOGS OF CANAL ZONE CLIMATE IN WEST CENTRAL AFRICA

1. Purpose and scope

This report is the fourth of a series comparing the climate of Cristobal and Balboa Heights in the Canal Zone with other tropical regions of the world. These two stations were selected to represent, respectively, the climates of the Atlantic and Pacific portions of the Canal Zone. The environment of Cristobal is described in a previous report (Wiley and others, 1955).

No attempt has been made to provide a regional climatology of West Central Africa. Instead, certain climatic elements have been selected as most significant, and for each of these a map has been made showing the distribution of conditions closely analogous to those of Cristobal and Balboa Heights. Some of the information presented on these maps of single climatic elements has been consolidated into 2 composite maps, 1 for each of the 2 Canal Zone stations, showing areas where there is a coincidence of analogy for up to 4 climatic elements.

2. Delimitation and geography of West Central Africa

West Central Africa is an area of tropical climate north of the Equator, west of 17° E longitude, and south of the Sahara Desert (Figure 2). Its climate is affected by mountains and plateaus, although it has only moderate relief.

a. Topography (Fig. 2)

The broadest coastal lowland in Africa south of the Sahara is that of Senegal in which the sudan reaches the sea. The 500-foot contour enclosing the lowland crosses the Senegal River nearly 500 miles east of Dakar. This lowland extends northward into Saharan Mauritania and Rio de Oro and southward to include Gambia and Portuguese Guinea. A little further south the coastal plain is interrupted where outliers of the Fouta Djallon mountain range meet the sea.

Except on a few outlying peaks in Sierra Leone and Liberia, the 1,000-foot contour remains at a distance of 100 to 200 miles from the coast as far as the head of the Bight of Biafra, despite the fact that the coast is quite hilly. The Niger Delta, which separates the Bights of Benin and Biafra, is the only large area on the coast without hills. It is occupied by a broad fan-pattern of small distributary streams. At the head of the Bight of Biafra, just east of the Niger Delta, Mount Cameroon (13,354 ft), the highest point in

West Central Africa, rises from the outer margin of the coastal lowland. It is separated from the Cameroons Mountains by a narrow lowland gap. Southward to the Equator the coastal lowland is less than 100 miles wide, and it is completely interrupted at steep Cabo San Juan.

The coastal highlands north and east of the Gulf of Guinea have two main areas of mountains. The Guinea Highlands including the Fouta Djallon (4,770 feet) form the western end of the highlands, just south of the Upper Senegal lowlands. The Cameroons Mountains (over 8,000 feet) extend northeastward from Mount Cameroon. Together with Mount Cameroon, they form a 500-mile continuation inland of a northeast-southwest line of mountains marked in the Gulf of Guinea by the islands of Annobon, São Tomé, Principe, and Fernando Po.

Between the Guinea Highlands and the Cameroons is a region of hills, low mountains, and low plateaus cut by numerous river valleys. A number of the valleys form considerable inland extensions of the coastal lowland, the most important being a trough along the lower Niger and Benue Rivers. South of the Cameroons Mountains lies the broad Cameroons-Gabon Plateau which is mostly above 2,000 feet and much less dissected than the highlands north of the Gulf of Guinea.

The relatively depressed zone that extends across the study area in French Sudan, just north of the highlands, is composed of three major basins, the Senegal Lowland, the Upper Niger Basin, and the Lake Chad Basin. Important mountains, mostly north of the major basins, are the Air, Adrar des Iforas, and the Ahaggar. West of these mountains are the Tanezrouft and El Djouf, extremely dry deserts.

b. Major climatic controls

Two strong currents of air influence the climate of West Central Africa. Warm or hot dry air from the Sahara moving southwestward as part of the Northern Hemisphere trade wind system is dominant in the northern part of the region throughout the year and reaches the southern part in the dry or winter season. Southwesterly wind from the Southern Hemisphere, locally called monsoon, moist because it blows off the South Atlantic, dominates east of the coast of the Gulf of Guinea and moves northward into the Sahara during the summer, bringing rain to that area.

This northward movement of the rains is associated with the seasonal northward movement of the sun and with the corresponding northward shift of the equatorial low pressure belt. The equatorial low is a migratory zone of convergence in which the opposing air is lifted, causing frequent heavy rains. In the southern part of the study area many stations have two maxima of rainfall which are associated with the northward passage and return of the low. Further north, in the French Sudan, the two rainfall maxima tend to merge into one. The summer dry season thus becomes shorter toward the north, and finally disappears. The winter

dry season becomes correspondingly longer northward until in the Sahara, beyond the range of the equatorial low, there is no wet season at all.

The regularity of the climatic pattern produced by this wind system is somewhat disturbed by other factors, especially topography. The two areas of very heavy rain on the coast of the Gulf of Guinea lie on the west and southwest or windward flanks of the two principal mountain ranges. The dry coastal region around Accra, northwest of the Bight of Benin, is sheltered from the rain-bearing west and southwest winds by hills and mountains. Relatively cool water in the Bight also contributes to local dryness.

3. Climatic summary of the Canal Zone

The Pacific portion of the Canal Zone, represented by Balboa Heights, has a moderately humid tropical climate with a relatively dry season of four months (Fig. 1). The difference in mean monthly temperatures of the warmest and coldest months is only 2 F°, and the range from the highest mean daily maximum (March and April, 90°F) to the lowest mean daily minimum (February, 71°F) is only 19 F°. The mean annual temperature of 79°F is typical of equatorial areas. Precipitation, averaging 70 inches annually, is markedly seasonal. Two months, February and March, have less than 1 inch of rainfall, and 5 months have more than 8 inches. The dry season begins in December and ends in April. Rainfall in each of the remaining months is more than 7 inches; October and November both have more than 16 inches. Relative humidity is high from June through November. Cloudiness is at a maximum from May through November, coinciding with the wet season; sky coverage averages about 8 tenths at Balboa Heights at that season. Wind speed, however, is greatest during the dry season: winds average 9 to 10 mph at Balboa Heights from January through April, but only about 5 to 6 mph in the other months. Southeastward toward the coast, there is a slight decrease in rainfall and an increase in temperature, as elevation drops to sea level from 118 feet at Balboa Heights.

The Atlantic portion of the Canal Zone, represented by Cristobal, has a wet tropical climate (Fig. 1). The difference in mean temperatures of the warmest and coolest months is only 2 F°, and the range from the highest mean daily maximum (April, May, June, September, and October, 86°F) to the lowest mean daily minimum (October and November, 75°F) is only 11 F°. The mean annual temperature of 81°F is typical of equatorial areas. Precipitation averages 130 inches a year, and the monthly distribution is uneven. Although no month can be considered completely dry, 2 months have less than 3 inches of rainfall, while 8 months have more than 11 inches. The drier season at Cristobal begins in January (3.4 inches) and ends in April (4.1 inches). During the remaining months, average rainfall ranges from about 12 to 22 inches. Mean relative humidity is high in all months: the lowest mean value, 77 percent, occurs in February and March. Cloud cover is greatest in July,

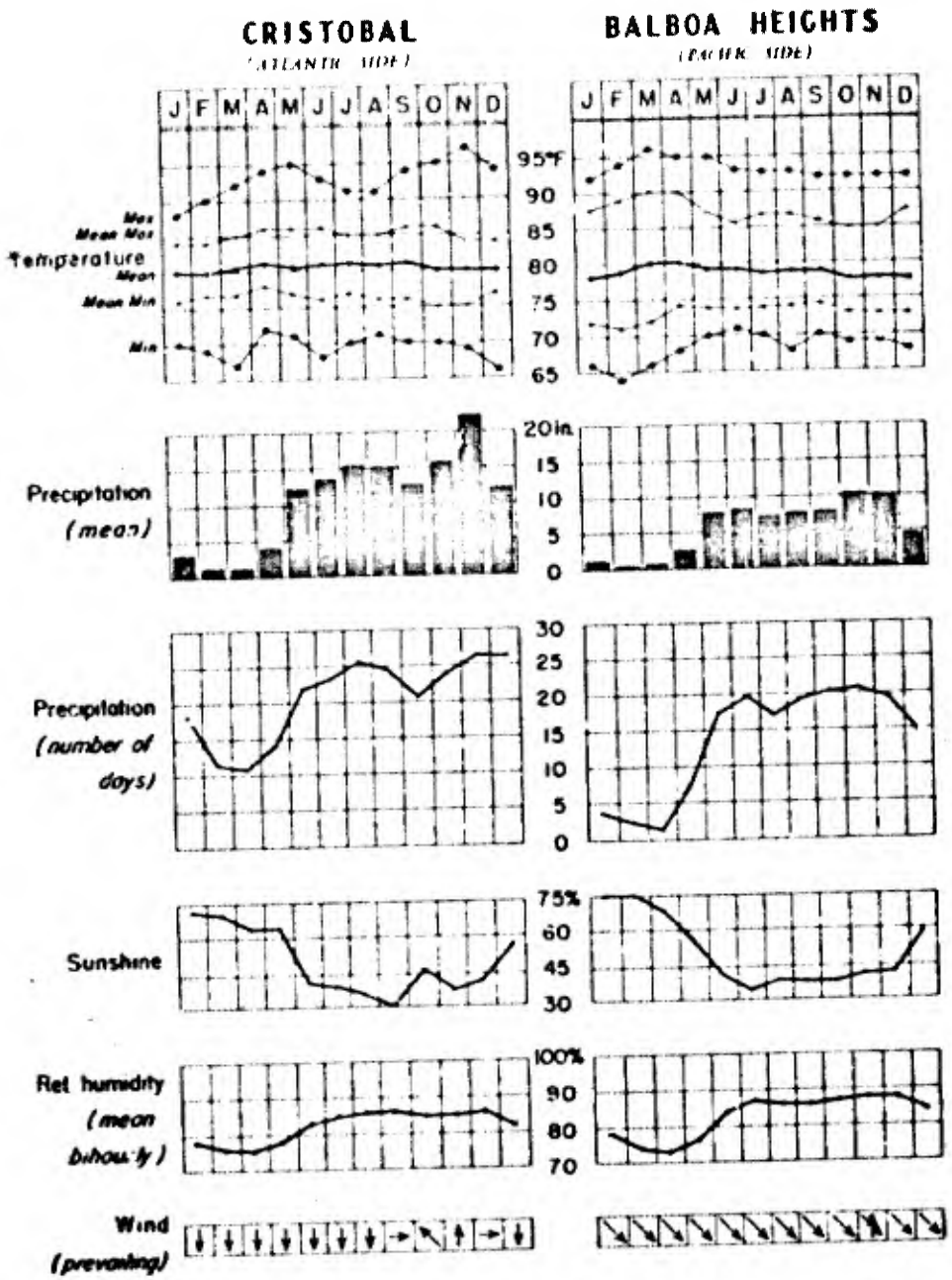

Figure 1. Climatic summary of two Canal Zone Stations

8 tenths, and least in February, 5.5 tenths. Mean wind speed is greatest in February and March (nearly 15 mph) and least in September (about 6 mph).

4. Criteria and methods

a. Climatic elements selected for study

As in the previous studies of this series, temperature, precipitation, humidity, cloud cover, and wind speed were the climatic elements considered most important to military activities. It was assumed that test authorities are more interested in stress periods (e.g., hottest and wettest) and annual fluctuations than in the data for specific calendar months. Accordingly, the warmest, coldest, wettest, and driest months of the year at each station were selected for study. The following specific combinations of elements and month were studied:

(1) Mean temperature of the warmest month
(2) Mean daily maximum temperature of the warmest month
(3) Mean temperature of the coldest month
(4) Mean daily minimum temperature of the coldest month
(5) Mean daily temperature range of the warmest month
(6) Mean annual precipitation
(7) Mean precipitation of the wettest month
(8) Number of wet months
(9) Relative humidity of the driest month
(10) Mean cloud cover of the wettest month
(11) Mean wind speed of the wettest month

b. "Analogous" and "semianalogous" ranges defined

Classes were established defining the ranges of values considered closely analogous to those for Balboa Heights and Cristobal. Fairly narrow limits of analogy were used to keep comparisons closely representative of the two reference stations. Table I lists the classes of analogy and semi-analogy selected for each element. For temperature, a departure of 4 degrees from the mean at the Canal Zone station was allowed for each analogy class (except where a mean was taken for the two reference stations), and an additional 4 degrees for semianalogy. For precipitation the mean annual rainfall of 70 inches at Balboa Heights is somewhat below that normally considered equatorial, therefore, in this study the limits of analogy were set at 55 to 85 inches, differentiating it from most evergreen rain forest areas, on the upper margin, and savanna areas, on the lower margin. Cristobal, which has a tropical evergreen rain forest type of climate, has a mean annual rainfall of 130 inches. Departures of 30 inches of mean annual rainfall were considered analogous to Cristobal, and an additional 30 inches was considered semianalogous. Departures of 5 percent in mean relative humidity, 1 tenth in amount of cloudiness, and 2 mph in wind speed were selected as ranges of analogy for these elements.

c. Explanation of maps

Values are shown for each station, with degree of analogy indicated by a symbol. Isopleths were drawn to show zones of close analogy, and these zones are shaded. Areas of semianalogy were not shaded but were indicated by placing the appropriate symbol on the map and legend for stations having semianalogous conditions. From the separate maps showing analogous areas for each element, two composite maps were prepared, one for Balboa Heights and one for Cristobal, indicating regions where the following 4 single elements are analogous: mean temperature of the warmest month, mean temperature of the coldest month, mean annual precipitation, and number of wet months.

d. Limitations of data

The procedures as outlined have certain definite limitations in a climatic comparison of this sort. Foremost among these is the necessity, often encountered in climatology, of assuming climatic conditions in areas having few if any stations.

A second limitation is that some elements, such as dew point, solar radiation, and visibility, which would have proved valuable as indicators of climatic analogy, were not included in this study because of the limited amount of data available.

For certain elements the number of stations reporting does not provide a representative picture. Consequently, isopleths were not drawn for mean relative humidity for the driest month, mean cloudiness for the wettest month, or mean wind speed for the wettest month. The assumption has been made that Balboa Heights and Cristobal are representative of the Pacific and Atlantic portions of the Canal Zone.

Data from some African stations are not given in a form directly comparable to Balboa Heights or Cristobal records. Where period of record, hours of observation, or manner of observation differed, station records had to be interpreted in drawing the isopleths. Values outside the limits of analogy or semianalogy were not analyzed, nor were combinations of climatic elements other than those involved in computing number of wet months.

The method of recording temperatures varies from country to country. Mean temperatures are usually determined by averaging the daily maximum and minimum temperatures; however, at some stations in East Central Africa the means are obtained by averaging bi-hourly temperature observations, as at Balboa Heights and Cristobal. Experience has shown that the difference between mean temperatures derived by these different ways is seldom more than 1 F°. Hours of observation of relative humidity, wind speed, and cloudiness vary widely throughout the study area.

5. Analysis of single-element maps

Individual maps showing analogous areas have been prepared for the climatic elements listed in paragraph 4a above, numbers 1 through 8. Maps of elements 9, 10, 11 have been prepared showing only the values for individual stations, since the data were considered inadequate for delimiting analogous areas.

a. Mean Temperature, Warmest Month (Fig. 3)

Balboa Heights and Cristobal have almost the same mean temperature for the warmest month (80° and 82°F, respectively). Figure 3, therefore, shows only one zone of analogy, lying between the 77° and 85°F isotherms. Most of the analogy shown on Figure 3 is south of 12° 30' N latitude. North of that line only the Ahaggar range and a narrow but continuous strip of coast are analogous; elsewhere it is too hot for analogy. Within the analogous zone the summits of the Ahaggar, the Guinea Highlands, most of the Cameroons Mountains, and a considerable part of the Cameroons-Gabon Plateau are too cool for analogy.

b. Mean Daily Maximum Temperature, Warmest Month (Fig. 4)

At Balboa Heights the mean daily maximum temperature for the warmest month is 90°F. At Cristobal, which has a less pronounced dry season, the corresponding temperature is 86°F. Analogous areas are those which have temperatures within 4 F° of these means. The 82° to 90°F range is thus analogous to Cristobal and the 86° to 94°F range to Balboa Heights; the range from 86° to 90°F is analogous to both.

In West Central Africa, analogy is closely confined to the coast except in areas sheltered by the Guinea Highlands and Cameroons Mountains from the high temperatures associated with Saharan winds. Analogy to Balboa Heights alone is continuous across the map, roughly paralleling the coast except in the Cameroons where its northern limit follows the inland margin of the highland. Inland extensions and "islands" of Balboa Heights analogy occur in the Fouta Djalon and on highlands north of the Benue River. Analogy to both stations occupies almost all of the immediate coast south of 7° 30' N (Sierra Leone). Along the northern coast, "dual" analogy is found on each peninsula. Dual analogy occurs in the Fouta Djalon, and is rather extensive between the Guinea Highlands and the sea. It also occupies practically the whole of the Cameroons Mountains and Cameroons-Gabon Plateau. Analogy to Cristobal alone occurs only on upper mountain slopes within the areas of dual analogy. Lack of analogy because of excessive coolness appears on the map only at high levels in the western Cameroons Mountains.

c. Mean Temperature, Coldest Month (Fig. 5)

Balboa Heights and Cristobal have similar mean temperatures

in their coldest month (78° and 80°F respectively), just as they do in their warmest month. For simplicity, a single 8 F° zone of analogy centered on a mean of 79°F (75° to 83°F) is presented on the map. As shown on Figure 5 the zone analogy occupies most of the southern half of the study area. Areas too cool for analogy include the whole northern half of the study region as well as the Guinea Highlands, the Cameroons Mountains, the Cameroons-Gabon Plateau, various other highlands, and areas on the coast of the Bight of Biafra and the western Bight of Benin.

d. Mean Daily Minimum Temperature, Coldest Month (Fig. 6)

At Balboa Heights the mean daily minimum temperature of the coldest month is 71°F, whereas at Cristobal it is 75°F. The 4 F° range of analogy used on each side of these means extends analogy with Balboa Heights to 67°F and with Cristobal to 79°F. Stations with temperatures between 71° and 75°F are analogous to both Canal Zone stations.

No area on Figure 6 is analogous to Cristobal alone. The total area of Balboa Heights analogy and dual analogy is considerably less than the area of dual analogy for mean temperature in the coldest month (Fig. 5). Analogy to Balboa Heights occurs on lowlands and in low mountain areas south of 12° N, which is the approximate northern limit of the coastal highlands and southern limit of the Sudan, and also on the eastern flank of the Cameroons Mountains and Cameroons-Gabon Plateau. Dual analogy is limited to lowlands and the coast. There is great diversity among stations even within the most consistently analogous area.

e. Mean Daily Temperature Range, Warmest Month (Fig. 7)

At Balboa Heights the mean daily temperature range in the warmest month is 16 F°, whereas at Cristobal, directly exposed to the trade winds from the sea, it is only 8 F°. A range of 4 F° on either side of these means is considered analogous. The 12 F° isotherm therefore separates the two zones of analogy.

Analogy is closely confined to the coast except on the Cameroons-Gabon Plateau, the coastal side of the Cameroons Mountains, and small areas in the Guinea Highlands. The analogous zone is seldom greater than 75 miles in width west of the Cameroons, though analogy is continuous on the coast south of 19° N. Analogy with Cristobal occurs only on the immediate shore at the head of the Bights of Biafra and Benin and on the northwestern shore of the Gulf of Guinea.

f. Mean Annual Precipitation (Fig. 8)

At Balboa Heights the mean annual precipitation is 70 inches, whereas at Cristobal it is 130 inches. A range of 30 inches on either side of the mean is considered analogous to Cristobal, whereas a 15-inch

range is used for Balboa Heights.

The two major wet regions in the study area are analogous to Cristobal: one on the windward side of the Guinea Highlands and the other on the windward side of the Cameroons Mountains. Within each of these there are small coastal areas too wet for analogy. The wettest spot is the seaward face of Mount Cameroon, which has an annual mean of approximately 400 inches of rain.

Balboa Heights analogy occupies coastal areas adjacent to wet regions and extends inland on the highlands. Areas too dry for analogy reach the coast only along the western shore of the Bight of Benin and along the Atlantic coast north of 13° N (Gambia).

The heaviest precipitation, aside from that on the seaward side of Mount Cameroon, falls on the coastal lowlands of the area rather than in the higher mountains. Only one high-level station, Bamenda, on the western flank of the Cameroons Mountains, has enough precipitation to be analogous to Cristobal.

g. Mean Precipitation, Wettest Month (Fig. 9)

At Balboa Heights the mean precipitation of the wettest month is 11 inches whereas at Cristobal it is 22 inches. Analogy with Balboa Heights is considered to extend from 8 to 14 inches and analogy with Cristobal from 15 to 29 inches.

Because the study area is more seasonal than the Canal Zone, especially as one moves northward from the Gulf of Guinea, analogy with respect to precipitation in the wettest month extends much further north than analogy with respect to annual precipitation. Balboa Heights analogy reaches a rather regular line extending from about 16° N at St. Louis, Senegal, in the west to about 13° N near Lake Chad in the east.

The principal change in Cristobal analogy from Figure 8 is greater extension in either direction along the coast. Outliers of such analogy also occur as much as 250 miles inland. A fairly large area too wet for analogy occurs on the seaward side of the Guinea Highlands. A similar area around Mount Cameroon is less extensive. The only area too dry for analogy south of sudan lies along the western part of the Bight of Benin.

h. Number of Wet Months (Fig. 10)

The wetness or dryness of a month has been determined on the basis of Thornthwaite's 1931 temperature-precipitation formula. Abbreviated values based upon this formula are given below. A month is considered wet if its monthly mean precipitation equals or exceeds the amount given opposite its monthly mean temperature in the tabulation.

Mean monthly temperature (°F)	Mean monthly precipitation (in.)
95	2.88
90	2.71
85	2.54
80	2.37
75	2.20
70	2.03
68	1.96

Balboa Heights has an average of 9 wet months according to this formula, whereas Cristobal has 10. Areas having a wet period one month longer or shorter than these means are considered analogous. A station with 8 wet months is thus analogous to Balboa Heights, one with 9 or 10 wet months is analogous to both Canal Zone stations, and one with 11 wet months is analogous to Cristobal. In Figure 10, areas with 12 wet months are considered nonanalogous and are found only at the head of the Bight of Biafra on the windward slope of Mount Cameroon and on the nearby coast. Areas of analogy with Cristobal alone occur on the outer Niger Delta and on the east shore of the Bight of Biafra. Dual analogy is continuous over the plateau and seaward mountain slopes of the Cameroons, as well as along the coast as far as western Liberia, except on a portion of the northeast coast of the Bight of Benin. The western shore of the Bight of Benin is dry too many months for analogy with Balboa Heights. The northern boundary of Balboa Heights analogy extends north of 10° N only in the western Guinea Highlands. Elsewhere, there are too many dry months for analogy.

i. Relative Humidity, Driest Month (Fig. 11)

The relative humidity of Balboa Heights is 75 percent in February, the month of least rainfall. The corresponding figure for Cristobal is 77 percent in February and March. Analogous stations are those having mean driest month humidities within 5 percent of these means. Balboa Heights analogy thus extends from 70 percent to 80 percent and Cristobal analogy from 72 percent to 82 percent. No areas of analogy are mapped on Figure 11 because of the sparsity of data and the difficulty of determining their comparability. The data shown indicate that analogy is usual in the wetter parts of the study area.

j. Mean Cloudiness, Wettest Month (Fig. 12)

Balboa Heights and Cristobal both have 7.6 tenths cloud cover in their wettest months. A range of 1 tenth on each side of the mean is considered analogous. No areas of analogy are drawn on Figure 12 because of sparsity of data, but inspection of the scattered stations shows that analogy is widespread.

k. Mean Wind Speed, Wettest Month (Fig. 13)

The mean wind speed of the wettest month at Cristobal is 8 mph. At Balboa Heights the corresponding figure is about 6 mph. A range of 2 mph on each side of each mean is considered analogous. Balboa Heights analogy thus extends from 4 to 8 mph and Cristobal analogy from 6 to 10 mph.

Although no areas of analogy are drawn on Figure 13 because of insufficient data, a number of widely dispersed analogous stations are shown.

6. Analysis of composite maps (Fig. 14 and 15)

Two maps, Figure 14 for Balboa Heights and Figure 15 for Cristobal, are presented to show the extent within the study area of composite analogy of the more important elements presented singly elsewhere. The elements for which areas of analogy are fully plotted on the composite maps are (1) the mean temperature of the warmest month, (2) the mean temperature of the coldest month, and (3) mean annual precipitation. Because of the importance of seasonality of precipitation in the tropics, areas which are analogous with respect to the number of wet months are also shown, but only where they occur within areas analogous with respect to the other three elements. This is done because full presentation of a fourth element would make the maps difficult to read.

Areas of three- or four-way analogy to one Canal Zone station or the other occupy practically the whole coast of the study area south of 13° N. except on the western shore of the Bight of Benin. Multiple analogy to Cristobal occurs over most of the areas of Cristobal analogy defined by Figure 8 (mean annual precipitation). The distribution of analogy to Balboa Heights is similar in Figures 8 and 14. Balboa Heights analogy is somewhat more extensive than Cristobal analogy because most of the area has a long, well-marked dry season.

7. Tables of monthly values

In order to show the month-by-month changes in the climatic elements considered in this report, a series of tables (Tables II to IX) is included showing mean values of each element for each month at 23 stations throughout the study area. The tables reveal certain characteristics of climatic analogy which are not manifest in the maps.

Port Etienne represents the Saharan coast. Mouderia, Araouan, and Kidal represent the interior Sahara. Dakar on the coast, and Kayes, Segou, Timbuktu, Niamey, Zinder, and Maiduguri in the interior are representative of the sudan. Mali is a station near the summit of the Fouta Djalon Mountains. Beyla, Bobo-Dioulasso, Yendi, and Zungeru are interior stations at various altitudes between the Gulf of Guinea and the sudan. Conakry, Monrovia, Grand Bassam, Lagos, Calabar, and Libreville are all Guinea Coast ports. Berberati is on the east flank of the Cameroons-Gabon Plateau on the rim of the Congo Basin.

TABLE I: CLIMATIC ELEMENTS AND CLASSES OF ANALOGY

Station index	Balboa Heights: Value at B.H. (mean)	Balboa Heights: Analogous (range)	Balboa Heights: Semianalogous (range)	Cristobal: Value at Cris. (mean)	Cristobal: Analogous (range)	Cristobal: Semianalogous (range)
TEMPERATURE (°F)			73-76			73-76
Mean, warmest month*	80	77-85	86-89	82	77-85	86-89
Mean daily maximum, warmest month	90	86-94	82-85 95-98	86	82-90	78-81 91-94
Mean coldest month*	78	75-83	71-74 84-87	80	75-83	71-74 84-87
Mean daily minimum, coldest month	71	67-75	63-66 76-79	75	71-79	67-70 80-83
Mean daily range, warmest month	16	12-20	8-11 21-24	8	4-12	0- 3 13-16
PRECIPITATION						
Mean annual (inches)	70	55-85	40- 54 86-100	130	100-160	70- 99 161-190
Mean, wettest month (inches)	11	8-14	5- 7 15-17	22	15-29	8-14 30-36
Number of wet months	9	8-10	7 11	10	9-11	8 12
RELATIVE HUMIDITY (%)			65-69			67-71
Mean, driest month	75	70-80	81-85	77	72-82	83-87
CLOUDINESS (tenths)			6.0-6.9			6.0-6.9
Mean, wettest month	7.6	7.0-8.9	9.0-10.0	7.6	7.0-8.9	9.0-10.0
WIND SPEED (mph)			2-3			4-5
Mean, wettest month	5.8	4-8	9-10	8	6-10	11-18

*See section 4b for explanation of ranges of analogy; sometimes a mean of the 2 reference stations is used.

TABLE II: STATIONS USED IN THE TABLES OF MONTHLY VALUES

Stations	Altitude (ft)	Latitude (N)	Longitude	Record (Yrs) Temp.	Prec.
Arrouan (French Sudan)	935	18° 54'	3° 33' W	8	7
BALBOA HEIGHTS (Canal Zone)	118	8° 58'	79° 35' W	12-34	22-38
Berberati (Fr. Eq. Afr.)	1949	4° 15'	15° 48' E	7	17
Beyla (Fr. Guinea)	2261	8° 41'	8° 39' W	8	9
Bobo-Doulasso (Upper Volta)	1421	11° 10'	4° 18' W	14	30
Calabar (Nigeria)	40	4° 58'	8° 19' E	25	41
Conakry (Fr. Guinea)	52	9° 31'	13° 43' W	11	19
CRISTOBAL (Canal Zone)	36	9° 25'	79° 52' W	7-32	8-60
Dakar (Senegal)	131	14° 44'	17° 30' W	25	29
Grand Bassam (Ivory Coast)	20	5° 12'	3° 44' W	6	19
Kayes (Fr. Sudan)	184	14° 26'	11° 26' W	16	26
Kidal (Fr. Sudan)	1371	18° 26'	1° 21' E	7	6
Lagos (Nigeria)	22	6° 27'	3° 24' E	21	51
Libreville (Fr. Eq. Africa)	243	0° 23'	9° 26' E	22	20
Maiduguri (Nigeria)	1185	11° 47'	13° 11' E	20	28
Mali (Fr. Guinea)	4803	12° 08'	12° 18' W	8	11
Monrovia (Liberia)	230	6° 18'	10° 45' W	4	4
Moudjeria (Mauritania)	66	17° 53'	12° 20' W	9	10
Niamey (Niger Territory)	715	13° 31'	2° 06' E	9	29
Port Etienne (Mauritania)	26	20° 54'	17° 01' W	14	18
Segou (Fr. Sudan)	974	13° 24'	6° 09' W	4	7
Timbuktu (Fr. Sudan)	886	16° 45'	2° 55' W	15	24
Yendi (Ghana)	686	9° 26'	0° 01' E	4	6
Zinder (Niger Territory)	1676	13° 48'	9° 00' E	10	21
Zengeru (Nigeria)	428	9° 48'	6° 10' E	20	22

TABLE III: MEAN MONTHLY TEMPERATURE (°F)

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Araouan	63	70	78	89	92	97	95	93	92	85	74	66	83
BALBOA HEIGHTS	78	79	80	80	79	79	79	79	79	78	78	78	79
Barberati	77	78	78	78	78	76	75	75	75	75	76	76	77
Beyla	74	79	80	80	78	76	74	73	74	75	76	73	76
Bobo-Doulasso	76	80	85	86	82	81	78	77	78	81	81	77	80
Calabar	78	80	81	80	80	78	78	77	78	78	80	78	79
Conakry	80	82	83	83	82	80	78	77	78	79	81	81	80
CRISTOBAL	80	80	81	82	81	81	81	81	81	80	80	80	81
Dakar	71	72	72	73	76	81	83	82	83	83	79	74	77
Grand Bassam	81	82	84	83	81	79	77	76	77	80	81	82	80
Kayes	77	81	88	94	96	90	84	82	84	86	84	77	84
Kidal	66	72	78	88	93	95	91	87	88	84	76	70	82
Lagos	81	82	83	82	81	79	77	77	78	79	81	81	80
Libreville	80	80	81	81	80	78	76	77	78	78	79	79	79
Maiduguri	74	78	85	92	92	88	83	80	82	84	80	74	83
Mali	65	70	72	73	72	67	65	64	65	66	66	66	68
Monrovia	79	81	81	82	81	79	77	78	78	79	79	81	80
Moudjeria	74	79	85	90	95	95	91	88	90	90	84	76	86
Niamey	75	80	86	93	93	89	85	82	85	87	83	77	85
Port Etienne	68	69	70	70	70	73	74	77	79	77	74	71	73
Segou	74	80	87	90	92	87	81	79	82	85	83	77	83
Timbuktu	71	74	82	89	94	94	91	88	90	89	80	71	84
Yaundi	80	84	85	84	82	79	77	76	77	79	80	79	80
Zinder	73	81	88	93	93	89	84	81	85	86	83	75	84
Zongoro	80	83	86	87	84	81	78	78	79	80	80	79	81

TABLE IV: MEAN DAILY MAXIMUM TEMPERATURE (°F)

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Araouan	80	90	98	110	111	115	113	110	109	104	97	83	101
BALBOA HEIGHTS	88	89	90	90	87	86	87	87	86	85	85	87	87
Berberati	89	90	91	89	88	87	84	84	85	86	87	89	87
Beyla	89	92	93	91	89	85	83	82	83	86	88	87	87
Bobo-Doulasse	92	96	100	99	92	91	87	85	87	92	94	92	92
Calabar	86	89	89	88	87	86	85	83	84	85	87	86	86
Conakry	87	89	91	91	90	87	84	82	85	86	87	87	87
CRISTOBAL	84	84	85	86	86	86	85	85	86	86	84	84	85
Dakar	79	80	80	81	84	88	89	87	89	89	85	81	84
Grand Bassam	89	90	91	91	88	84	82	83	84	86	88	89	87
Kayes	92	97	105	110	109	101	93	91	93	95	99	92	98
Kidal	80	88	95	105	109	113	107	102	104	100	92	86	98
Lagos	87	89	89	89	87	85	83	82	83	85	88	88	86
Libreville	88	88	89	89	88	85	83	84	85	86	86	87	86
Maiduguri	92	96	104	108	107	101	94	89	93	96	98	91	98
Mali	71	75	79	80	77	72	69	68	70	72	72	73	73
Monrovia	88	88	89	89	89	85	82	81	84	87	86	89	87
Moudjeria	88	95	102	108	113	112	108	103	106	107	99	90	102
Niamey	92	97	103	108	106	103	99	94	96	103	102	95	99
Port Etienne	79	82	81	82	80	83	83	86	90	89	87	83	84
Segou	89	98	104	106	105	100	92	88	91	97	98	93	97
Timbuktu	86	91	99	106	110	109	105	100	104	104	96	87	100
Yendi	93	97	97	95	91	88	84	83	84	88	93	93	91
Zinder	90	97	105	109	108	102	95	92	98	103	99	91	99
Zengeru	95	98	100	98	94	90	86	85	87	92	95	95	93

TABLE V: MEAN DAILY MINIMUM TEMPERATURE (°F)

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Aracuan	46	51	58	68	73	79	77	77	75	66	57	49	65
BALBOA HEIGHTS	72	71	72	74	74	74	74	74	74	73	73	73	73
Barberati	65	65	67	67	67	66	66	66	66	65	65	63	65
Beyla	59	66	68	68	68	66	65	65	65	65	64	58	65
Bobo-Doulasso	60	64	70	73	72	70	70	69	69	70	67	62	68
Calabar	71	72	73	72	72	71	71	71	71	72	72	71	72
Conakry	72	74	75	75	75	73	72	72	72	72	75	74	74
CRISTOBAL	76	77	77	78	77	76	77	76	76	75	76	77	76
Dakar	64	63	64	65	68	74	76	76	77	77	73	67	70
Grand Bassam	74	75	77	75	74	74	72	70	71	73	74	74	74
Kayes	62	65	72	78	83	79	75	74	74	74	69	62	72
Kidal	51	56	61	70	78	79	75	73	73	69	61	55	67
Lagos	74	77	77	76	75	74	74	73	74	74	75	75	75
Libreville	72	72	73	72	72	70	68	69	71	71	71	72	71
Maiduguri	56	60	66	75	76	75	73	72	72	70	63	57	68
Mali	59	64	65	65	66	63	62	61	61	62	60	59	62
Monrovia	71	74	73	75	73	72	73	72	72	73	72	72	73
Moudjeria	60	63	68	73	77	77	75	73	74	73	68	63	70
Niamey	59	64	69	78	80	77	75	74	75	72	64	58	70
Port Etienne	56	56	58	59	61	63	65	68	69	65	61	58	62
Segou	59	63	70	74	79	75	71	71	72	72	68	61	69
Timbuktu	55	57	65	72	78	79	77	75	76	73	63	55	69
Yendi	67	70	73	74	72	70	70	70	69	69	68	66	70
Zinder	57	64	72	78	78	75	72	71	72	72	66	58	70
Zengeru	66	68	73	76	74	72	71	71	71	70	65	63	70

TABLE VI: MEAN MONTHLY PRECIPITATION (inches)

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Araouan	T	0.1	T	T	T	0.6	0.4	0.5	0.9	0.1	0.1	T	2.7
BALBOA HEIGHTS	1.0	0.6	0.7	2.9	8.0	8.4	7.3	7.8	8.2	10.2	10.5	4.7	70.3
Berberati	1.0	2.0	2.6	5.0	7.9	5.7	5.2	7.6	8.5	9.3	3.5	0.8	58.8
Beyla	0.2	1.6	4.5	5.2	5.6	8.5	10.0	11.4	12.5	7.5	3.3	0.8	72.2
Bobo-Doulasso	•	0.1	0.7	1.9	3.8	5.1	8.0	11.6	7.9	3.7	0.5	0.1	42.6
Calabar	1.8	2.4	6.2	8.6	12.3	16.7	18.7	18.1	16.1	12.4	7.3	2.0	132.7
Conakry	T	0.1	0.2	0.8	6.3	21.4	50.7	39.7	26.3	13.4	4.3	0.5	165.7
CRISTOBAL	3.4	1.5	1.5	4.1	12.5	13.9	15.6	15.3	12.8	15.8	20.3	11.7	130.4
Dakar	•	•	•	T	•	0.7	3.4	9.7	5.0	1.4	0.1	0.2	20.7
Grand Bassam	1.7	2.3	5.5	8.4	14.9	25.0	6.7	1.4	2.0	5.6	9.6	3.9	86.9
Kayes	•	T	•	0.1	0.9	3.8	6.8	8.5	5.4	1.4	0.1	•	27.2
Kidal	0.0	•	0.0	•	0.2	0.2	1.0	2.5	1.1	•	0.0	•	5.1
Lagos	1.1	1.7	4.0	5.9	10.5	18.3	10.7	2.4	5.2	8.0	2.7	1.0	71.6
Libreville	9.7	9.6	13.0	13.3	9.6	0.8	0.1	0.8	4.9	14.1	14.8	10.0	100.7
Maiduguri	•	0.0	•	0.3	1.6	2.7	7.3	8.7	4.3	0.6	0.0	0.0	25.6
Mali	0.1	T	•	1.5	5.5	12.2	16.4	19.3	13.6	6.6	1.1	0.2	75.3
Monrovia	0.1	0.1	4.3	11.7	13.4	36.1	24.8	18.6	29.9	25.2	8.2	2.9	175.3
Moudjeria	•	0.0	0.0	0.0	0.1	0.5	0.9	2.8	1.5	0.3	0.2	0.3	6.7
Niamey	•	T	0.1	0.4	1.3	3.1	4.7	9.4	3.0	0.7	•	0.0	22.8
Port Etienne	0.1	•	0.1	•	•	•	•	0.5	0.2	•	0.1	0.3	1.4
Segou	0.0	0.0	•	0.2	1.6	4.1	7.5	8.5	4.1	0.6	•	0.0	26.8
Timbuktu	0.0	T	•	0.1	0.1	0.8	2.7	2.6	1.3	0.1	T	•	7.8
Yendi	0.5	0.5	1.9	3.6	3.7	6.6	7.4	8.8	10.9	3.7	0.2	0.1	47.2
Zinder	0.0	0.0	T	•	0.5	2.1	5.9	8.9	2.7	0.4	•	0.0	20.6
Zengeru	0.0	0.0	0.5	2.4	4.8	6.7	7.5	9.0	10.8	3.5	0.1	0.1	45.4

• Quantities greater than a trace but not more than .05 inch.

TABLE VII: MEAN CLOUDINESS (tenths of sky covered)

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Araouan	1.5	1.7	1.2	0.8	1.0	1.1	1.3	1.8	1.1	0.9	1.5	1.5	1.3
BAUCA HEIGHTS	4.8	4.8	5.0	6.3	7.6	8.0	7.6	7.7	7.7	7.7	7.6	6.3	6.8
Berberati	5.2	7.3	7.3	7.3	7.9	7.5	7.9	8.4	7.9	7.5	6.9	4.2	7.1
Beyla	1.4	2.1	2.7	4.5	4.5	5.7	5.8	6.1	6.0	4.8	3.4	2.2	4.1
Bobo-Doulasso	1.5	1.8	2.8	3.5	4.1	4.0	4.4	4.8	4.1	2.9	1.7	1.2	3.1
Calabar	7.6	7.2	7.5	7.1	7.2	7.1	7.4	8.8	8.0	8.2	7.7	7.2	7.6
Conakry	2.4	2.4	2.2	3.0	4.4	5.8	7.5	7.5	6.3	5.5	4.2	2.7	4.5
CRISTOBAL	5.9	5.5	5.8	6.4	7.8	7.9	8.0	7.6	7.1	7.4	7.6	6.8	7.0
Dakar	4.4	4.0	3.4	3.2	3.7	4.7	5.7	6.8	6.0	4.7	5.1	5.1	4.7
Grand Bassam	5.2	4.8	5.5	5.2	6.5	5.8	5.3	7.1	7.2	4.7	6.1	6 3	5.8
Kayes	3.1	2.8	2.6	2.5	4.3	4.9	5.3	5.8	4.7	3.9	2.9	3.1	3.8
Kidal	1.5	1.4	1.7	1.4	1.4	1.7	1.6	2.3	1.7	1.1	1.1	1.8	1.6
Lagos	4.5	4.7	4.9	5.2	5.3	5.8	5.6	5.4	5.5	5.6	5.1	4.9	5.2
Libreville	6.3	6.6	6.8	6.6	7.1	7.3	7.2	7.5	7.4	7.3	7.2	6.8	7.0
Maiduguri	0.2	0.2	0.3	0.4	0.5	0.4	0.5	0.6	0.6	0.3	0.2	0.2	0.4
Mali	2.8	1.8	1.4	2.8	4.1	4.5	5.7	5.2	4.9	3.5	2.9	2.7	3.5
Monrovia	5.2	6.1	5.1	3.7	5.9	7.8	8.0	8.3	7.2	6.7	5.2	4.3	6.1
Moudjeria	2.2	1.9	1.9	1.9	1.8	2.6	1.9	2.3	2.4	1.5	2.1	2.0	2.0
Niamey	1.6	1.5	1.8	2.8	3.2	3.4	4.1	5.1	3.8	2.6	1.5	1.4	2.7
Port Etienne	1.2	0.7	0.7	0.8	1.0	0.8	0.9	0.9	0.9	1.1	1.2	1.6	1.0
Segou	2.2	1.4	2.2	2.1	3.7	3.5	4.0	5.3	4.4	2.8	1.8	2.1	3.0
Timbuktu	2.6	2.3	2.4	2.4	2.8	3.2	3.5	4.0	3.5	2.7	2.3	2.7	2.9
Yendi	0.8	1.3	1.9	3.4	5.2	5.6	6.6	6.9	6.9	4.1	2.0	1.0	3.8
Zinder	1.4	0.9	0.9	1.9	1.5	2.0	2.6	3.3	2.6	1.4	0.8	0.8	1.7
Zongeru	1.6	1.9	3.1	4.8	5.3	6.1	7.3	7.2	6.0	4.0	2.4	1.3	4.3

TABLE VIII: MEAN RELATIVE HUMIDITY (%)

Stations	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Aracuan	53	50	37	31	29	37	42	50	49	50	46	49	44
BAUCHI HEIGHTS	76	75	73	77	85	87	86	87	87	88	88	84	83
Berberati	73	69	72	80	82	84	85	86	86	85	82	75	80
Beyla	74	79	79	70	79	87	91	91	92	89	92	81	84
Bobo-Dioulasse	34	35	40	52	62	69	73	87	80	70	55	41	59
Calabar	81	81	82	82	84	87	86	88	86	85	84	82	84
Conakry	75	76	73	73	76	83	88	88	87	84	82	79	80
CRISTOBAL	78	77	77	79	83	85	86	86	85	85	86	82	82
Dakar	64	66	72	73	74	75	76	81	82	79	71	66	73
Grand Bassam	84	85	83	80	85	86	87	90	88	86	84	84	85
Kayes	30	24	25	24	34	57	72	82	78	67	44	39	48
Kidal*													
Lagos	74	76	77	76	80	84	84	86	82	81	78	77	80
Libreville	85	86	86	86	86	84	82	84	84	88	87	86	85
Maiduguri	34	31	28	32	44	55	70	78	70	47	31	32	46
Mali	50	39	39	52	65	82	88	94	88	84	72	55	67
Monrovia	80	84	84	86	84	88	86	86	87	86	83	81	85
Moudjeria	43	45	47	41	44	44	58	68	63	54	49	47	50
Niamey	29	29	25	30	43	54	66	75	69	55	36	34	46
Port Etienne	61	65	73	77	80	76	79	78	73	69	72	54	71
Segou	28	29	36	35	46	57	73	80	78	64	44	36	52
Timbuktu	26	22	18	17	25	36	48	58	48	31	25	29	32
Yendi	26	30	44	62	70	76	82	85	83	77	56	35	60
Zinder	23	22	23	18	29	46	56	67	58	36	23	24	35
Zongoro	38	40	52	68	75	82	84	86	83	79	68	42	66

* No data available

TABLE IX: MEAN WIND SPEED (mph)

Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
Araouan	2.4	3.4	3.2	3.1	3.7	4.2	4.2	4.8	3.8	4.2	3.4	5.5	3.8
BALBOA HEIGHTS	8.8	10.1	10.3	8.8	6.1	5.4	5.9	5.9	5.6	6.3	5.8	6.4	7.1
Berberati*													
Beyla*													
Bobo-Doulasso	1.6	---	1.6	3.8	3.6	3.6	2.4	1.4	1.4	0.8	0.0	0.0	---
Calabar	9.1	13.7	14.8	12.6	12.6	12.1	12.6	11.6	10.6	11.1	10.1	10.6	11.6
Conakry	5.7	6.5	6.2	6.8	6.8	6.6	6.7	6.4	5.2	4.5	3.5	3.7	5.7
CRISTOBAL	14.1	14.8	14.8	12.5	8.0	6.6	8.1	7.9	6.1	6.6	8.0	11.8	9.9
Dakar	8.2	9.6	10.6	10.0	9.3	5.6	5.0	5.4	5.2	5.3	7.8	8.6	7.6
Grand Bassam	5.4	6.0	6.8	6.8	6.4	5.6	6.2	4.9	4.0	5.0	5.2	6.0	5.7
Kayes	2.2	2.4	2.8	2.9	4.2	4.4	4.0	3.2	2.6	2.1	2.0	2.0	2.9
Kidal	2.0	2.0	5.0	4.0	4.0	5.0	5.0	2.0	2.0	2.0	2.0	1.0	3.0
Lagos	2.4	5.2	6.4	5.5	3.9	4.7	8.6	9.9	8.0	4.1	4.0	2.8	5.4
Libreville*													
Maiduguri	9.0	9.9	10.1	9.5	8.2	6.8	6.6	6.1	5.5	5.5	8.4	8.4	7.8
Mali	3.7	2.7	3.6	2.4	3.0	2.8	1.1	2.4	1.2	2.9	2.2	2.6	2.6
Monrovia*													
Moudjeria*													
Niamey	10.0	8.0	10.0	11.0	14.0	12.0	12.0	9.0	8.0	6.0	6.0	9.0	9.6
Port Etienne	13.8	13.8	18.0	17.6	18.8	20.2	18.2	15.6	16.4	13.3	13.6	10.0	15.8
Segou*													
Timbuktu	4.0	4.3	4.6	4.2	4.2	4.7	5.2	5.3	4.6	4.3	4.2	4.4	4.5
Yendi*													
Zinder	6.7	5.8	4.5	4.8	5.4	5.0	4.7	3.5	3.2	3.0	3.4	4.6	4.6
Zongoru*													

*No data available

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10. Maps

Figure	
3	Mean temperature, warmest month
4	Mean daily maximum temperature, warmest month
5	Mean temperature, coldest month
6	Mean daily minimum temperature, coldest month
7	Mean daily temperature range, warmest month
8	Mean annual precipitation
9	Mean precipitation, wettest month
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11	Relative humidity, driest month
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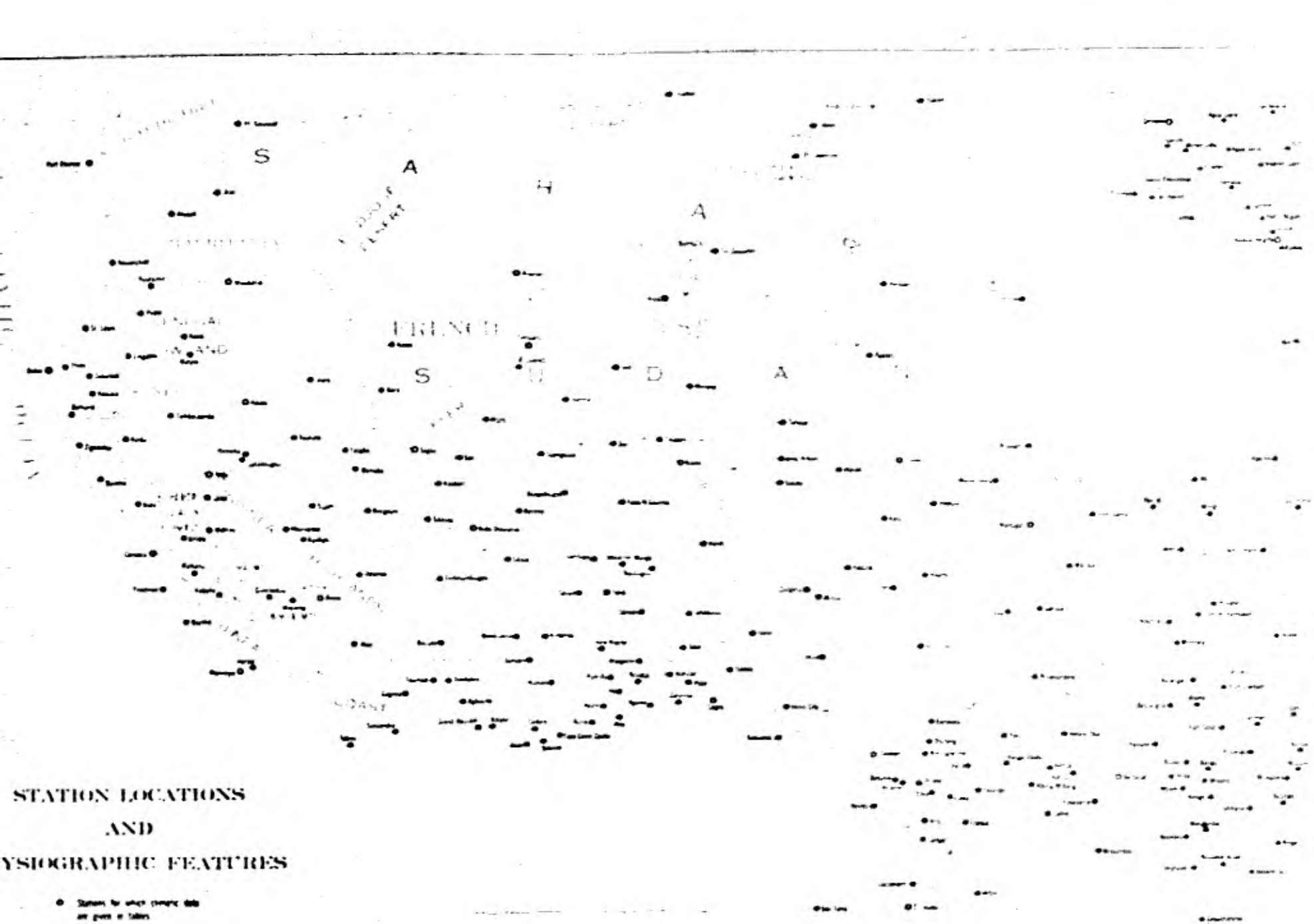
14	Composite of analogous areas - Balboa Heights
15	Composite of analogous areas - Cristobal


S
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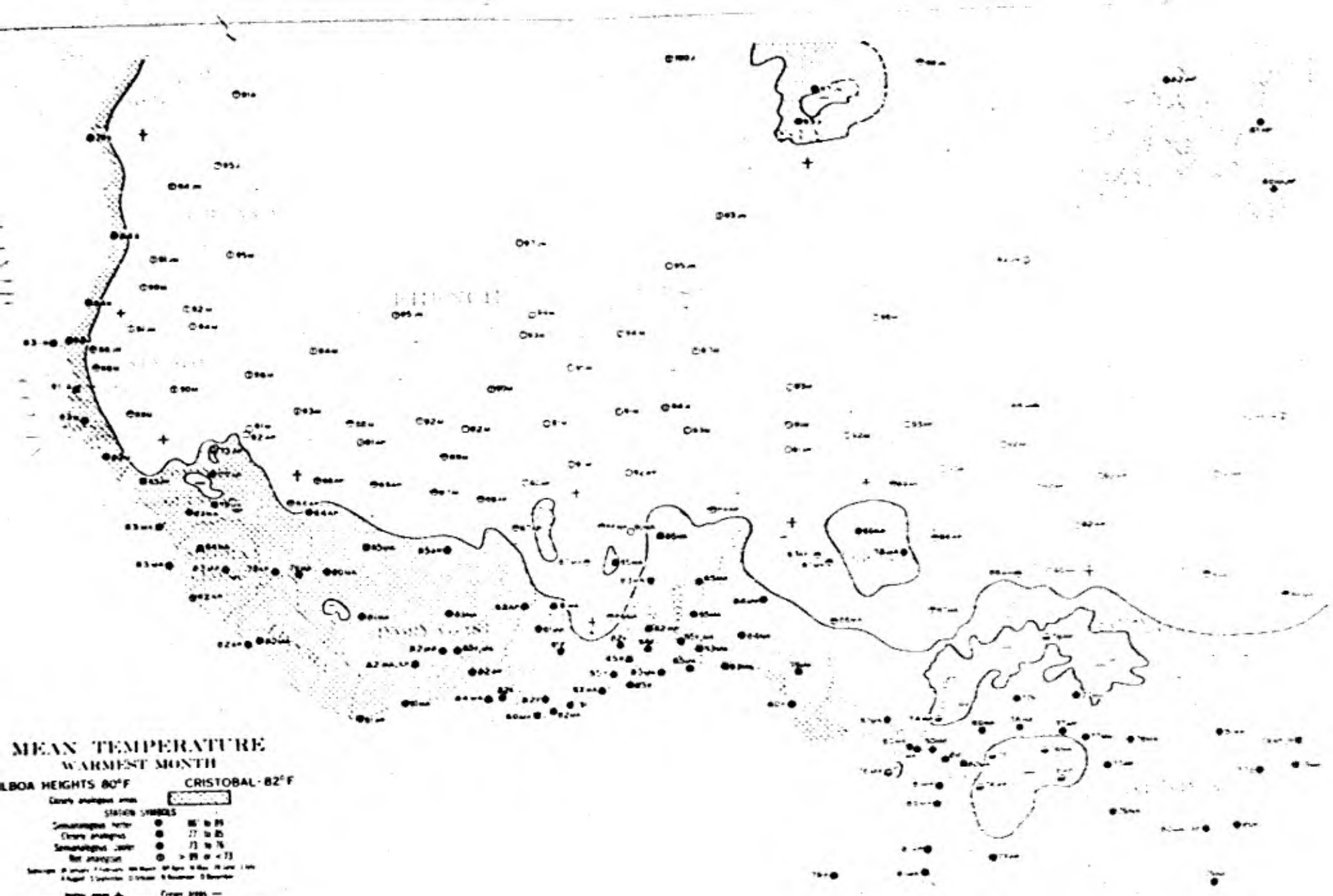
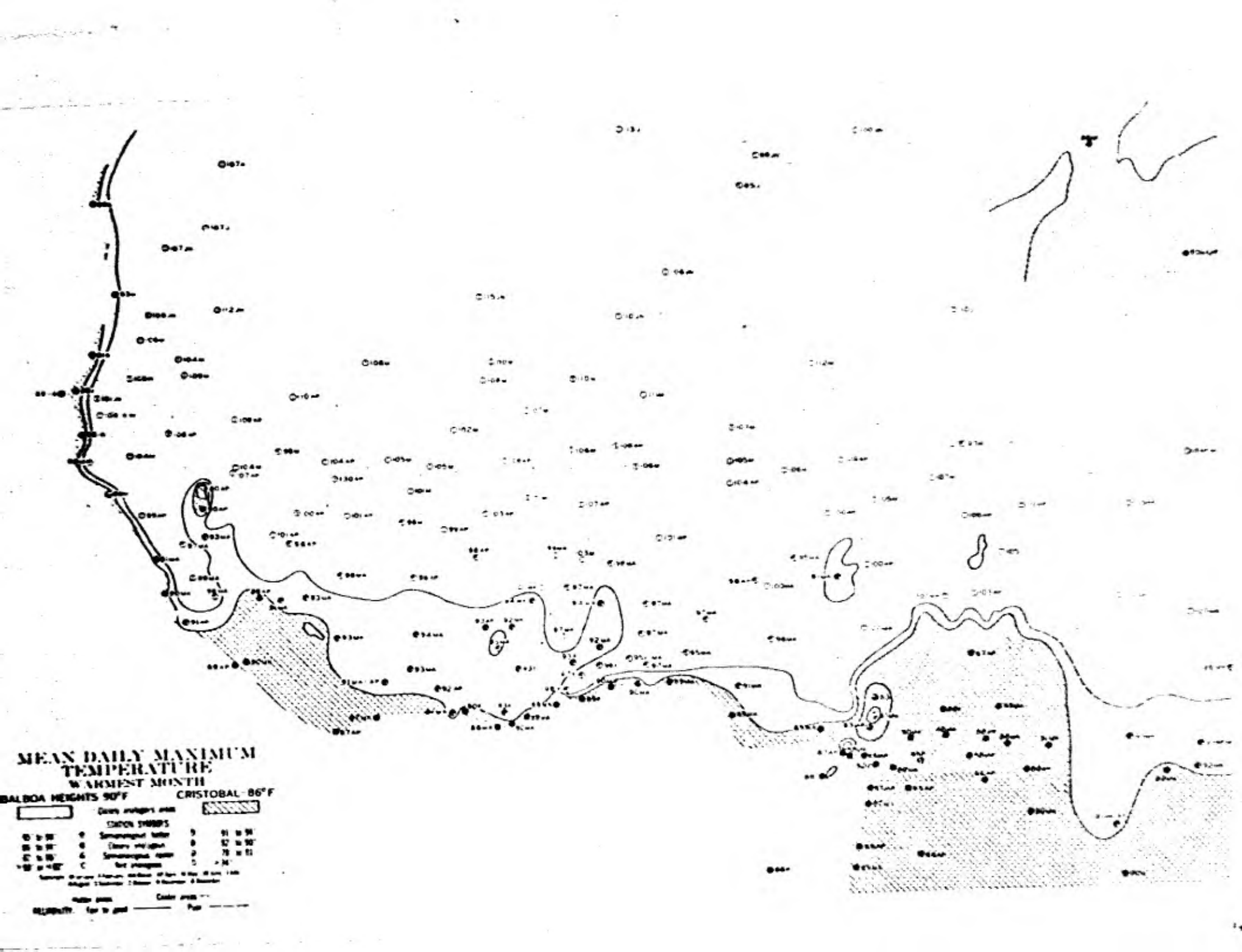
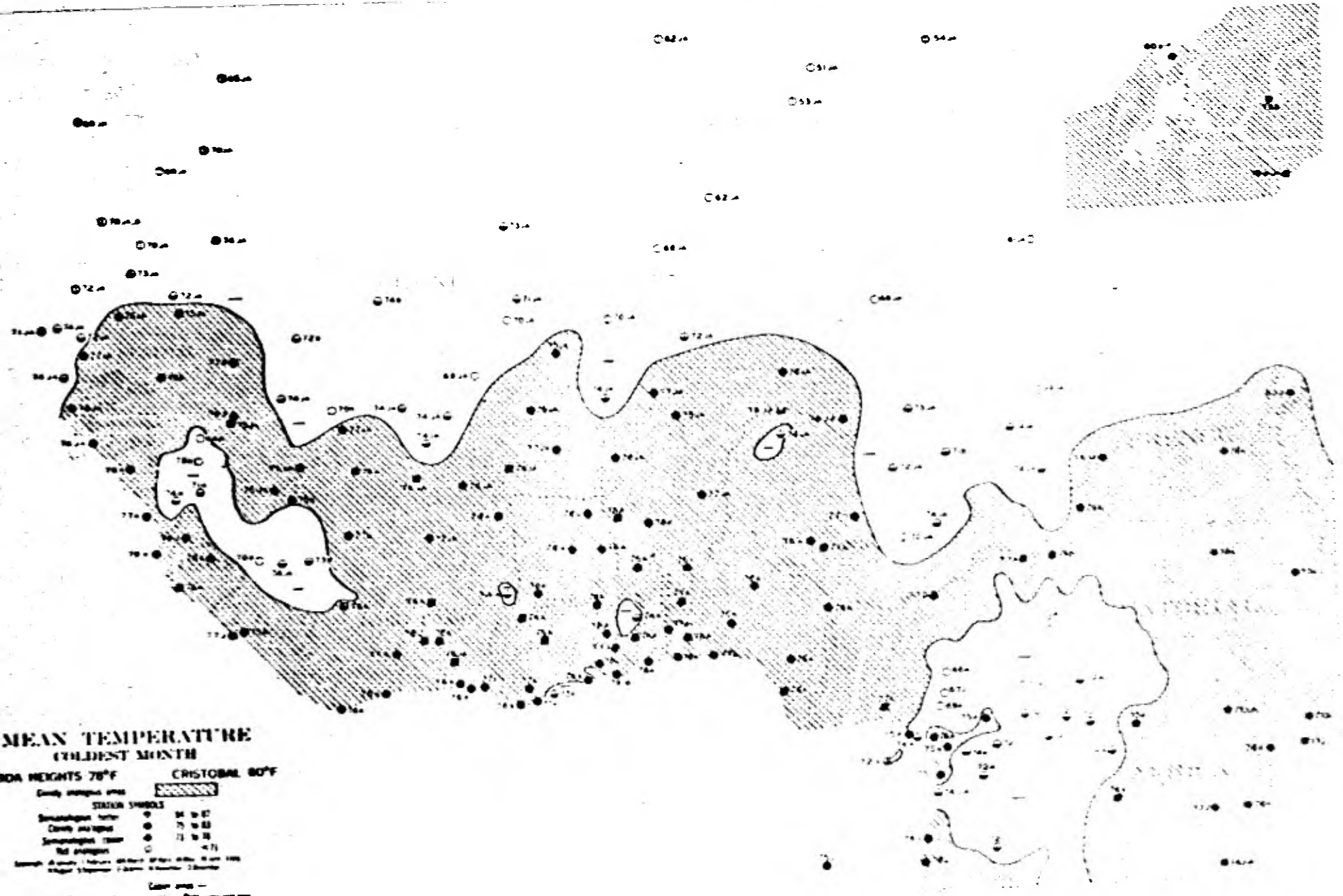
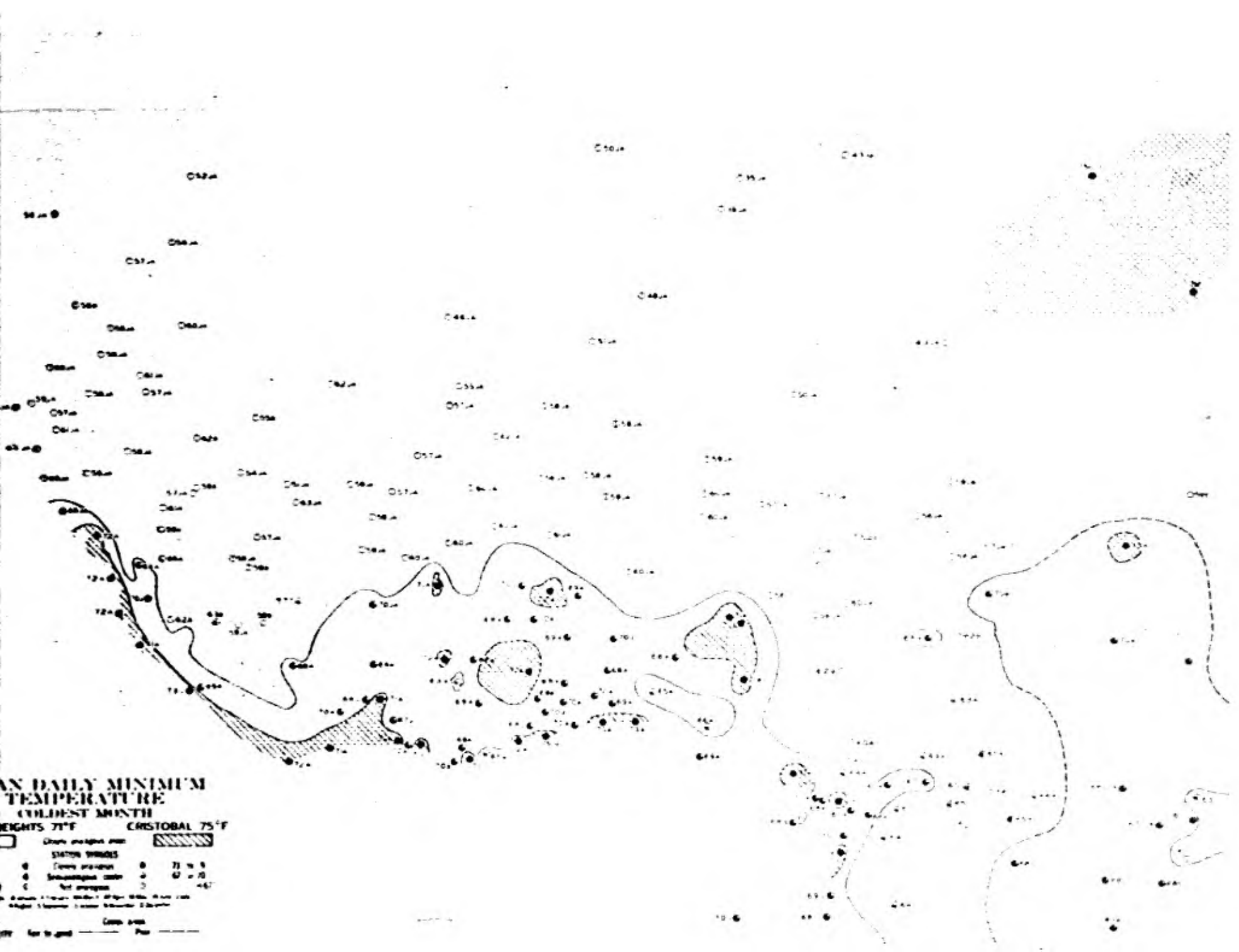
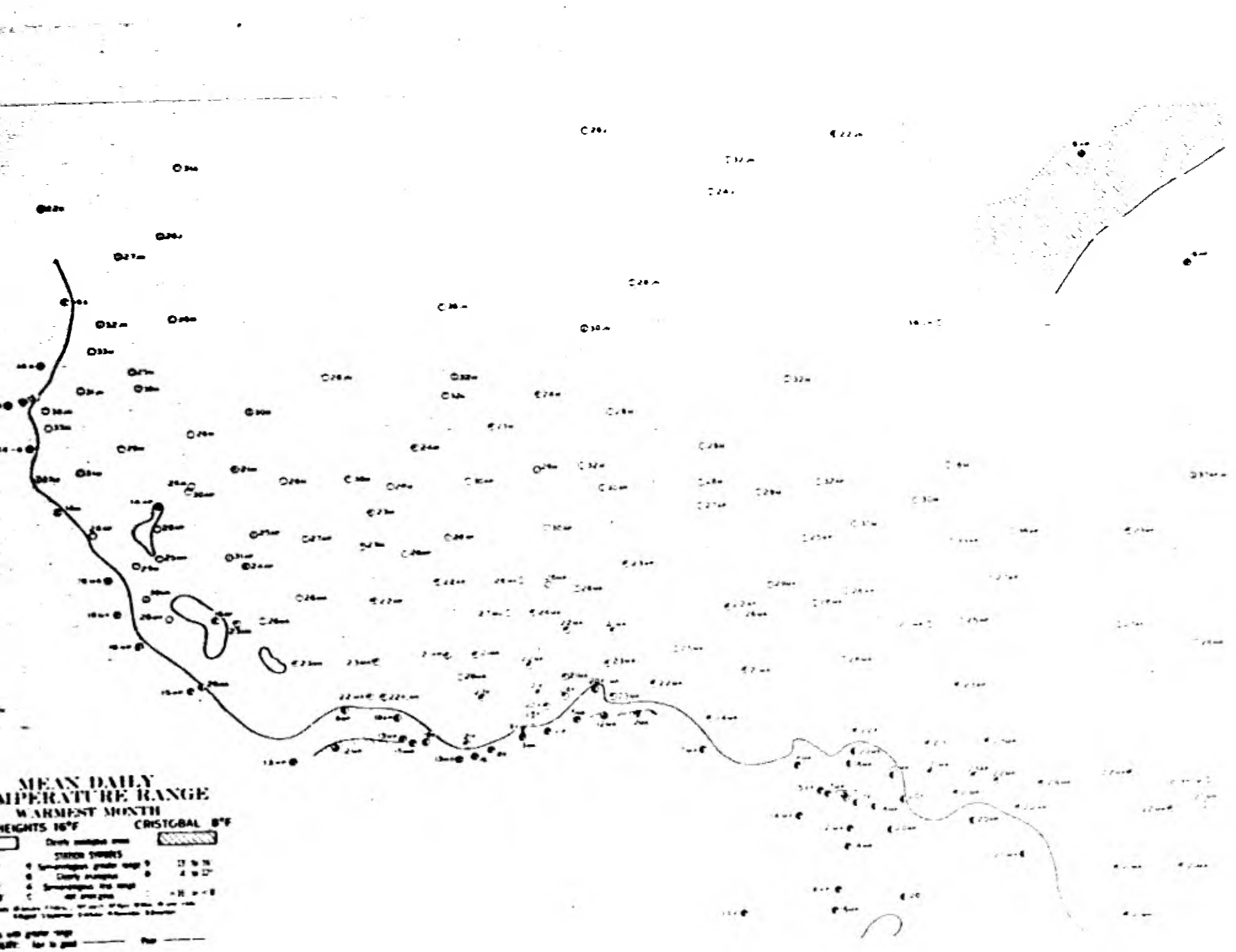
STATION LOCATIONS
AND
YSIOGRAPHIC FEATURES


MEAN TEMPERATURE
WARMEST MONTH
LBOA HEIGHTS 80°F
CRISTOBAL-82°F


MEAN DAILY MAXIMUM
TEMPERATURE
WARMEST MONTH
BALBOA HEIGHTS 90°F
CRISTOBAL 86°F

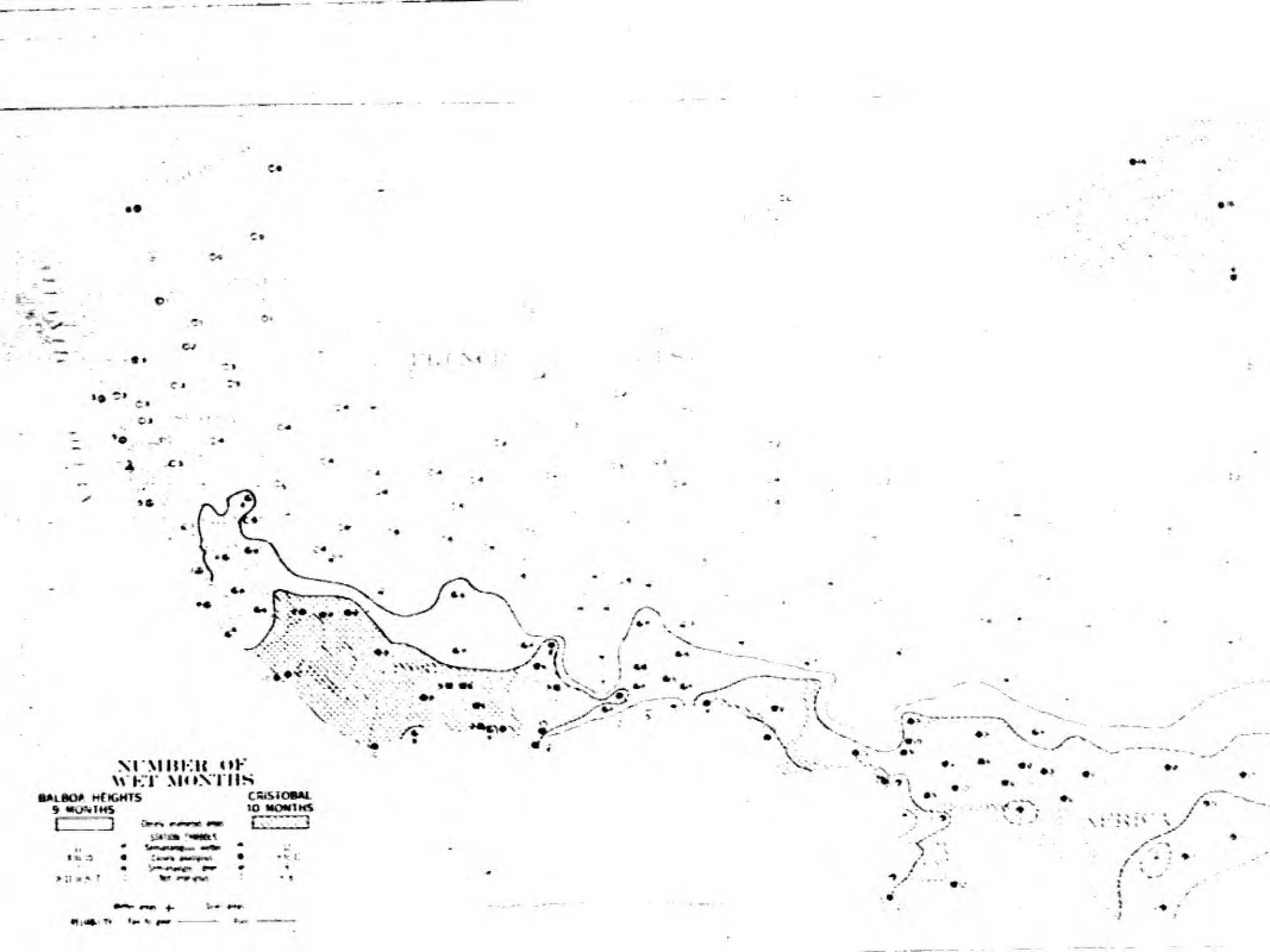

MEAN TEMPERATURE
COLDEST MONTH
CRISTOBAL 80°F

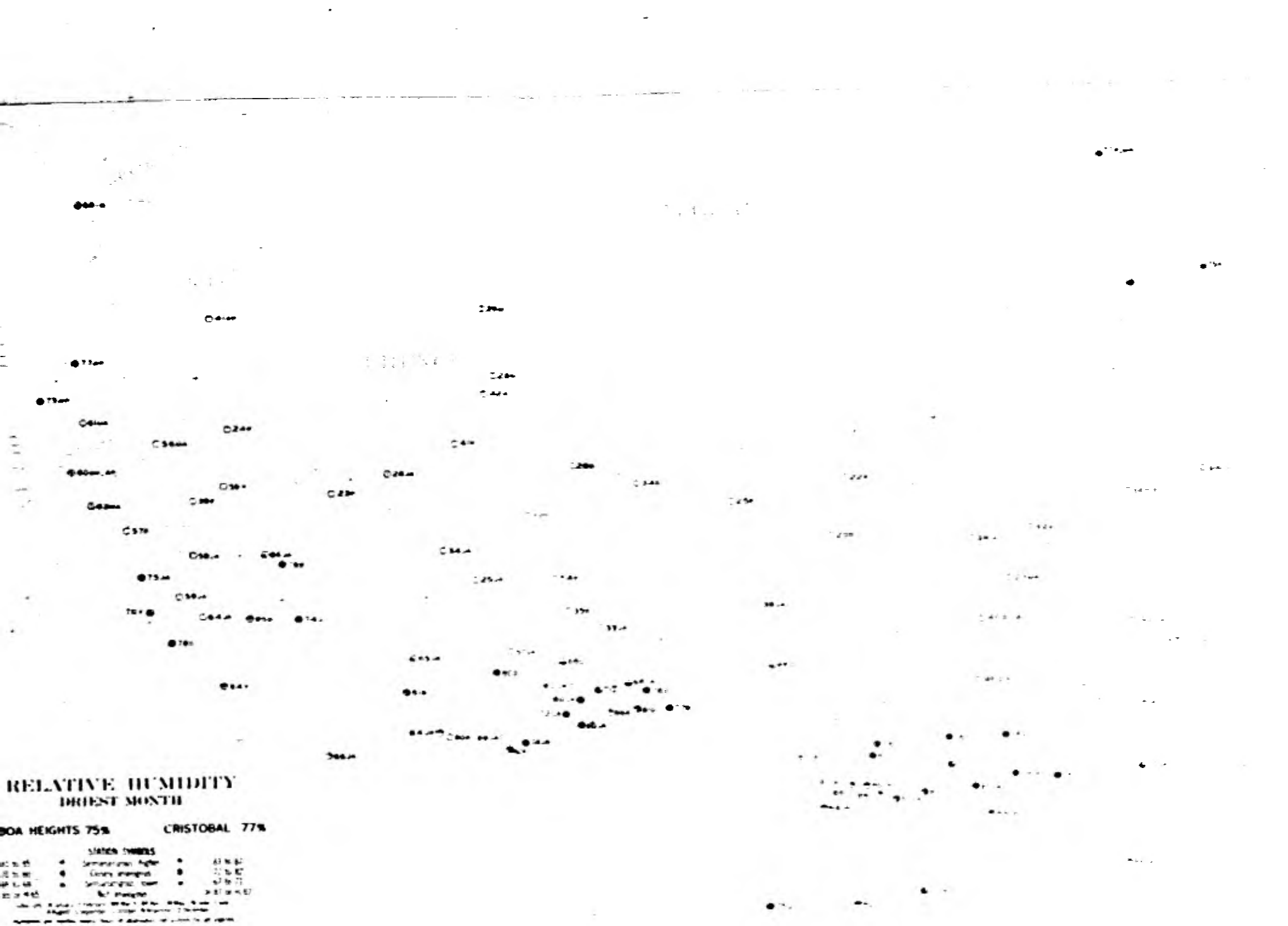

AN DAILY MINIMUM
TEMPERATURE
COLDEST MONTH
EIGHTS 71°F
CRISTOBAL 75°F


MEAN DAILY
MPERATURE RANGE
WARMEST MONTH
HEIGHTS 16°F
CRISTOBAL 8°F


MEAN ANNUAL
PRECIPITATION
BALBOA HEIGHTS
70 INCHES
CRISTOBAL
130 INCHES

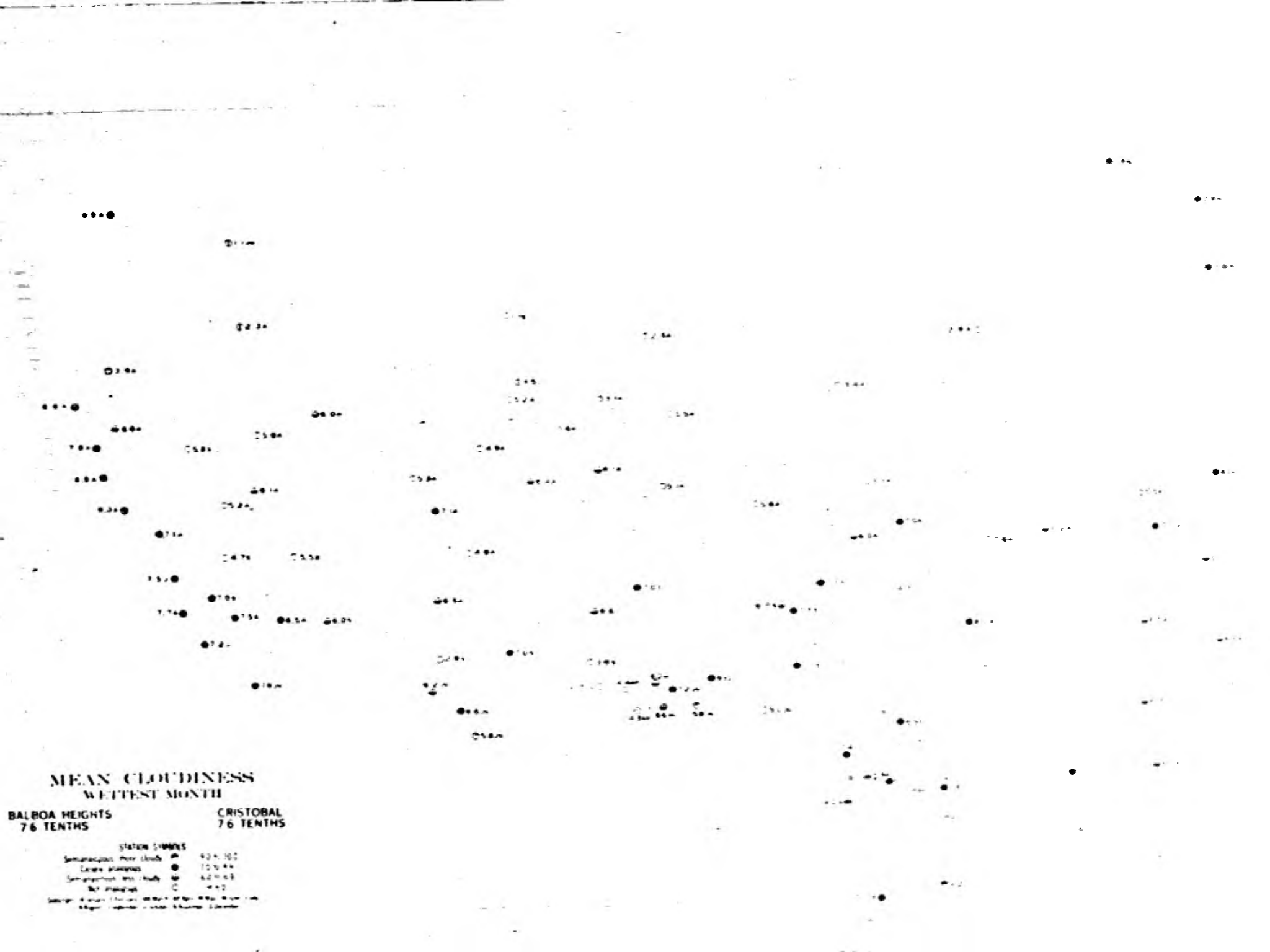

MEAN MONTHLY
PRECIPITATION
WETTEST MONTH
ALBOA HEIGHTS 11 RL
CRISTOBAL 22 RL

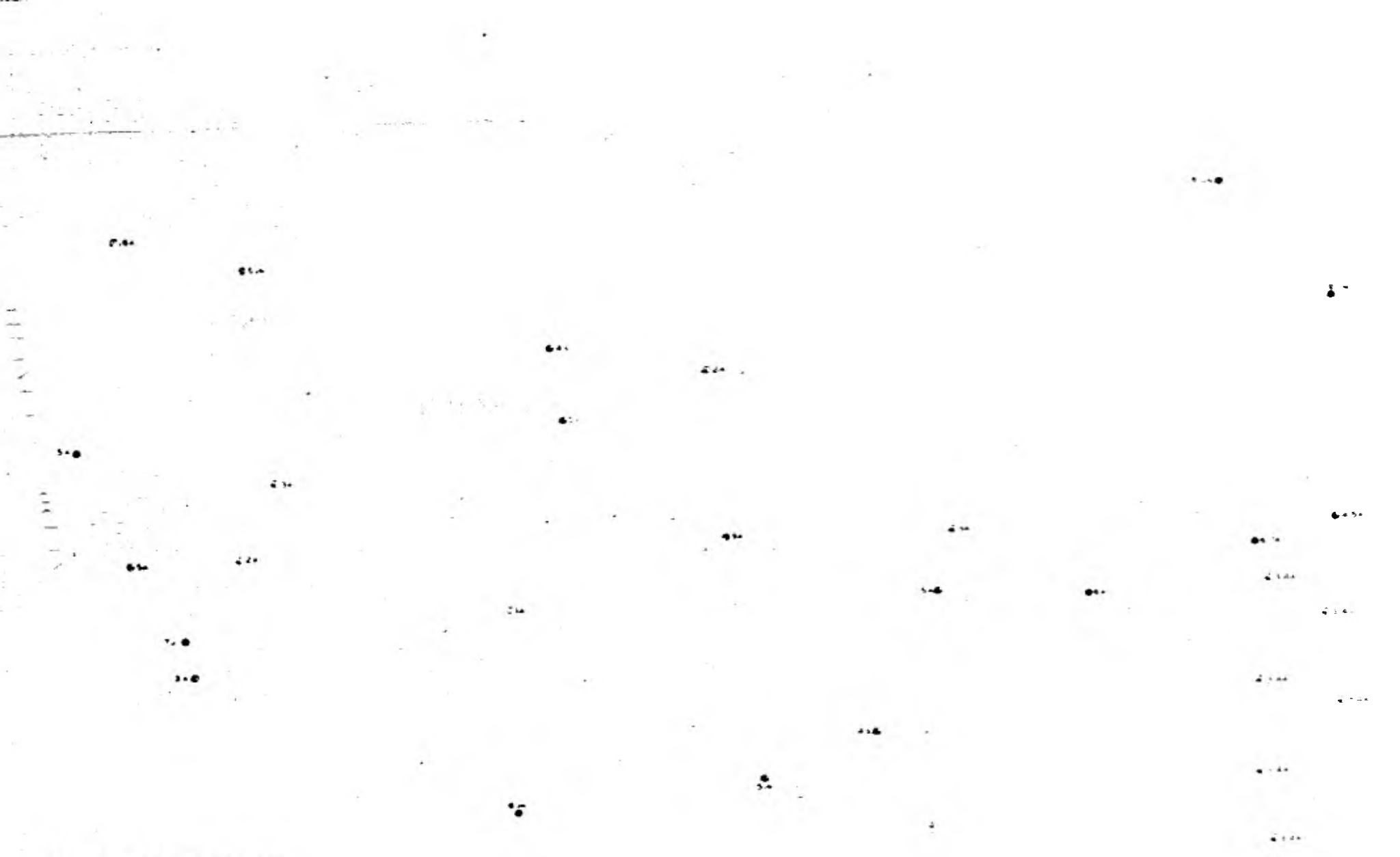

NUMBER OF
WET MONTHS
BALBOA HEIGHTS
9 MONTHS
CRISTOBAL
10 MONTHS



RELATIVE HUMIDITY
DRIEST MONTH

BOA HEIGHTS 75% CRISTOBAL 77%

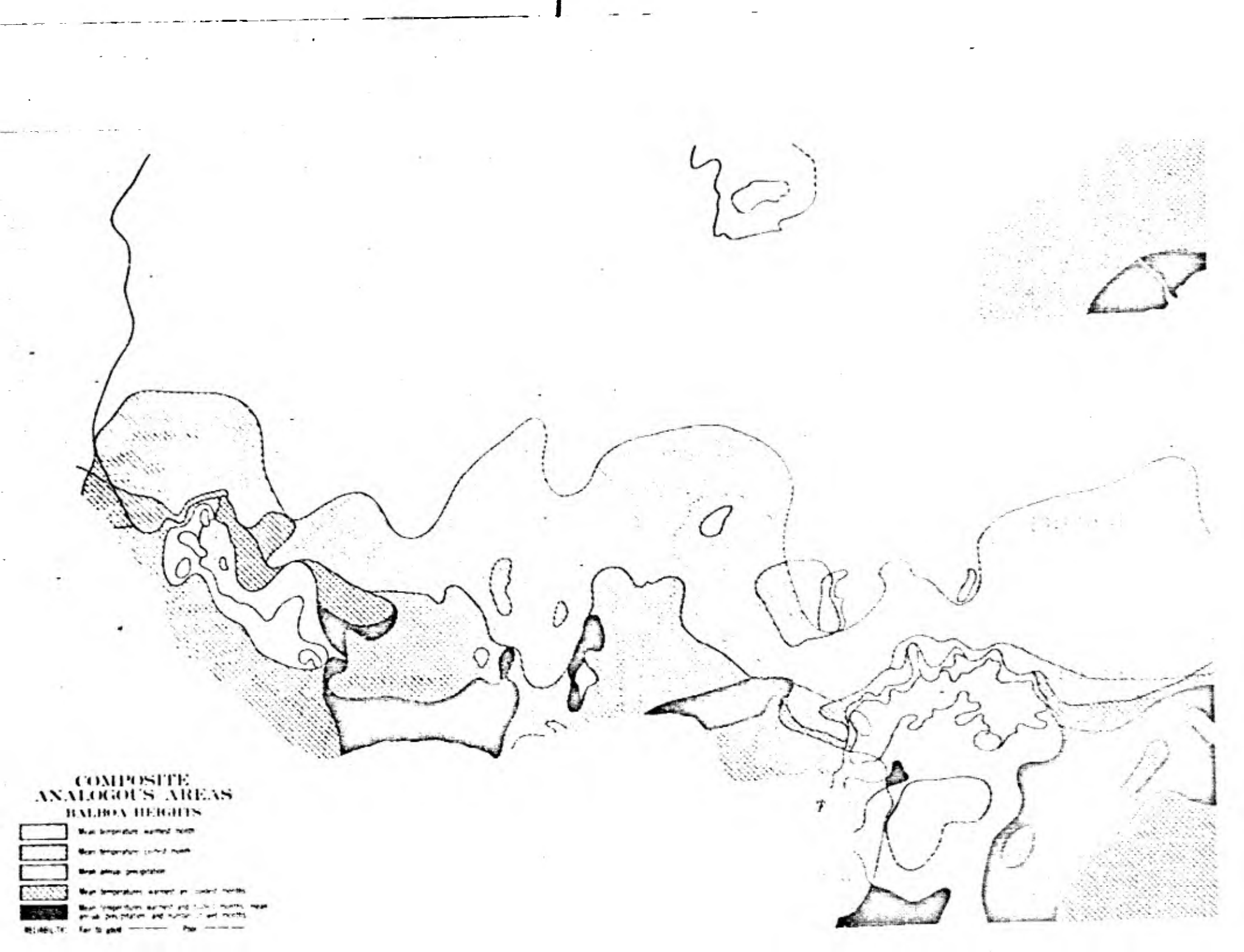

MEAN CLOUDINESS
WETTEST MONTH
BALBOA HEIGHTS
76 TENTHS
CRISTOBAL
76 TENTHS

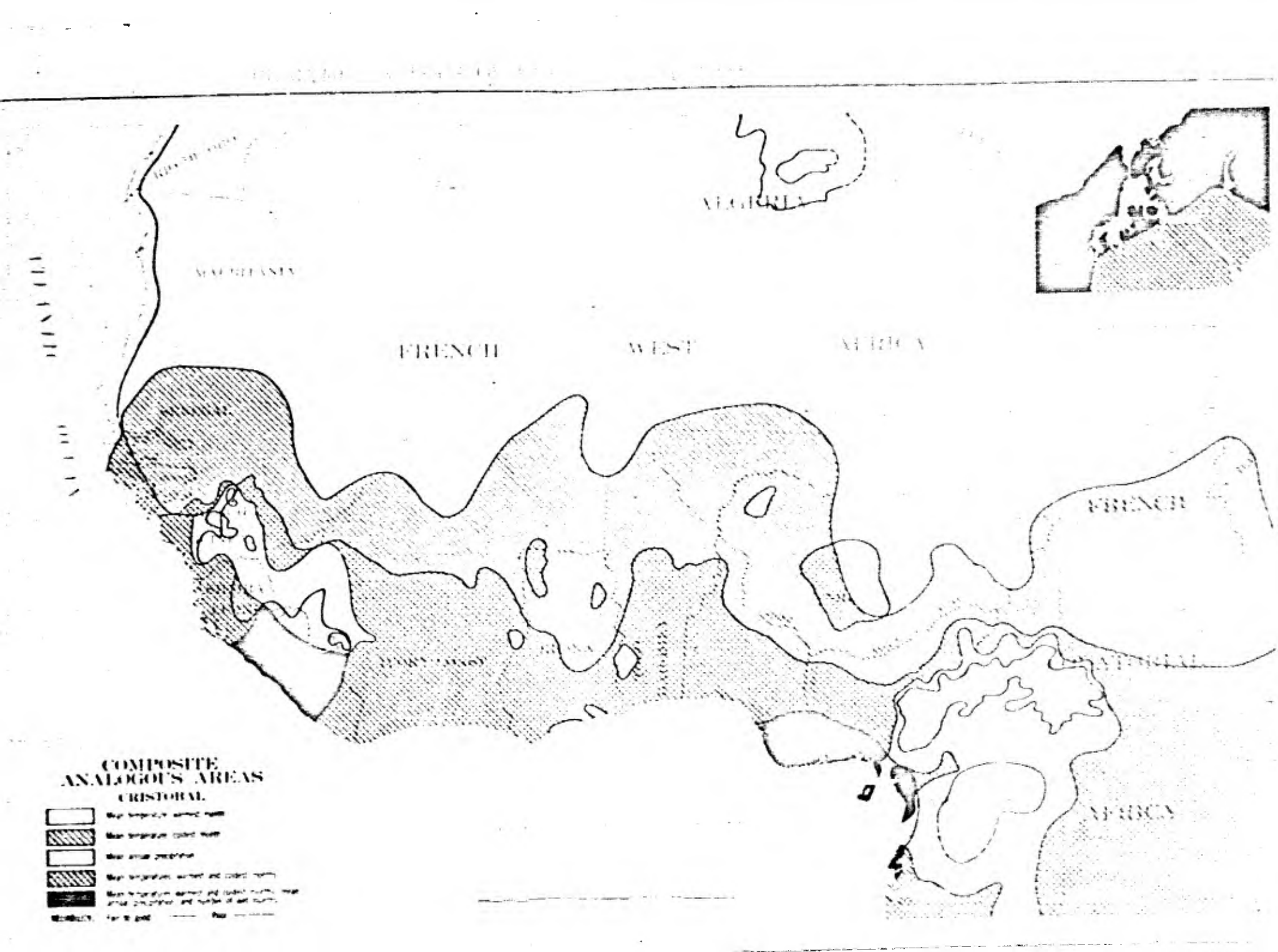


MEAN WIND SPEED
WETTEST MONTH

BALBOA HEIGHTS 5.8 MPH CRISTOBAL 8 MPH

STATION SYMBOLS


COMPOSITE
ANALOGOUS AREAS
BALBOA HEIGHTS


ALGERIA
MAURITANIA
FRENCH WEST AFRICA
FRENCH
AFRICA
COMPOSITE
ANALOGOUS AREAS
CRISTOBAL

HEADQUARTERS
QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY
OFFICE OF THE COMMANDING GENERAL
NATICK, MASSACHUSETTS

Major General Andrew T. McNamara
The Quartermaster General
Washington 25, D.C.

Dear General McNamara:

This report, "Analogs of Canal Zone Climate in West Central Africa", is the fourth of a series of studies comparing the climates of tropical areas with the climate of the Canal Zone.

The report presents information for military planners and test personnel on the extent to which the climates of Balboa Heights and Cristobal in the Canal Zone resemble those of West Central Africa. Thus it suggests the applicability to other tropical regions of the results of clothing and equipment tests conducted in the Canal Zone.

Sincerely yours,

C. G. Calloway

C. G. CALLOWAY
Major General, USA
Commanding

1 Incl
EP-93